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ABSTRACT

One area explored in the second (in-depth) phase of the Learning in Science Project was "children's science," defined as views of the world and the meanings for words that children have and bring with them to science lessons. The investigation reported focuses on the concepts of "living" held by 32 students in four different class levels (Standard 4, Form 1, Form 3, and Form 5). Data were obtained by the "interview-about-instances" procedure in which students were shown diagrams on cards which represented different instances (such exemplars as butterfly, tree) and non-instances (such non-exemplars as book, bicycle) related to the concept "living." Selections from interview transcripts are presented, discussed, and analyzed under the following headings: (1) use of scientifically-acceptable attributes; (2) animism--categorizing non-living things as living; (3) use of idiosyncratic criterial attributes; (4) use of non-critical attributes; (5) attributes used to categorize plant instances; (6) distinction between "book" and "story"; and (7) use of a nmemonic to recall a set of attributes of living things. One finding reported is that only five students had a concept of living similar to that of a biologist. Additional findings and (in an appendix) interview transcripts not included in the analysis sections are provided. (JN)

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WORKING PAPER No 15

LIVING

A working paper of the Learning in Science Project

Beverley Stead

June 1980

INTRODUCTION

This investigation describes the concepts of 'living' held by some 32 pupils in four different class levels - Standard 4, Form 1, Form 3 and Form 5.

The method of obtaining data was an 'interview - about - instances' procedure developed by Osborne and Gilbert (1979). This method is based on the idea that a particular concept held by a person can be explored by asking the person to distinguish between instances and non-instances of the scientifically accepted concept and by asking them to give the reasoning behind their action.

With respect to the concept 'mammal' for example, a person is said to have the scientifically acceptable concept if she can distinguish between instances of the concept (eg. cow, dog, man) and non-instances (eg. bird, fish, worm) and give acceptable scientific reasons for the action (eg. suckles the young). Such reasons, in fact, represent one or more of the set of criterial attributes for the concept. The acceptable scientific reasons are the criterial attributes that would be used by a biologist to distinguish between exemplars and non-exemplars. Not all attributes are criterial, of course. Whilst warm blooded is an attribute of all mammals it is also an attribute of birds, therefore it is not a criterial attribute of mammals. It does not distinguish mammals from other animals; it does not distinguish between instances and non-instances of the concept.

Pupils often do not distinguish between instances and non-instances in a scientifically acceptable manner, nor is their reasoning always based on scientifically acceptable criterial attributes. However, exploring pupils' concepts in the manner described above can lead to an understanding of not only whether pupils hold a scientifically acceptable concept, but, perhaps even more importantly, what concept they do hold. Initial interviews with children can lead to the inclusion of certain 'instances' and 'non-instances' of a concept in the interview schedule which enable the non-scientific concepts held by children to be identified more clearly.

Thirty-two pupils from four different schools, across approximately nine classes were interviewed. The teachers were asked to select children of average ability for the investigation. However, this was not always possible and the pupils of above average ability are indicated in Fig 1. There were 17 boys and 15 girls in the sample, including 27 Europeans and 5 Polynesians.

In an interview situation, the pupils were shown diagrams on cards (only one per card) which represented different exemplars and non-exemplars of the concept under investigation. The illustrations on the cards shown, in the sequence of presentation, were: book, boy, seagull, fire, snail, bicycle, worm, car, sun, mushroom, vacuum cleaner, rock cod,grass, butterfly, cloud, tree, river, candle, and spider. Illustrations of living things (both animal and plant) and non-living were represented on the cards. A sample of the cards is illustrated in Fig 2.

The interviews were structured in the sense that the sequence of cards was the same, and the same two questions were asked with each card in the interview. The two questions asked were:

1. 'Is the _____ living?'
2. 'What tells you that?'

The first question investigated if the pupils categorised the instance as an exemplar or non-exemplar of the concept; the second investigated the reasoning (the set of criterial attributes) used to make the categorisation. However, further questions were asked when appropriate, in order to gain a clearer understanding of each pupil's concept under investigation. The beginning of each interview, after introductions, was as follows:

> "I'm interested in science lessons and, in particular, the different meanings people have for different words. For example,the teacher may use a word in a class, you'll mean one thing by it and the person sitting next to you may mean something slightly different. I would like to learn from you what you mean by the word 'living'."

The first question with the first card (and with later cards if need be) was "In your meaning of the word 'living', is a _____ living?" At the end of the interview the pupil was asked to give her meaning of the word 'living', in a sentence or two.

The pupils were individually interviewed in a small room or office. The interviews were taped with the consent of the pupil, and later transcribed to obtain a written record of the interview for the later collation of results.

ANALYSIS OF THE INTERVIEW TRANSCRIPTS

The criterial attributes as perceived by the pupils were used to determine the framework of the analysis. (Table I).

Statements made in the analysis are illustrated or supported with quotations from the transcripts. An example of such a quotation is:

"Yes, he can move." (boy, 007,112,125,313,314,510,512,514).

The interpretation of this quote is as follows:

1. The "Yes" was the answer given to the first question, "Is the boy living?" The boy was categorised as living.
2. "He can move" was the reply to the second question "What tells you that?" 'That the boy can move' was the criterial attribute used to categorise the boy as living.
3. "Boy" indicates the instance to which this quote refers.
4. The number 007 indicates the pupil whose answer is quoted.
5. Numbers 115 to 514 indicate the pupils who gave answers, similar in meaning to that of pupil 007, but not necessarily identical in wording.
6. The triple code number, eg. 007, represents one pupil. The first number indicates the class level. (0 for Standard 4; 1 for Form 1; 3 for Form 3; and 5 for Form 5.) The next two numbers refer to a particular pupil. For example, pupil 313 was the thirteenth pupil interviewed from Form 3.

Only two or three representative quotations have been given in the analysis section to illustrate any one point. Interested readers are referred to Appendix A for a more comprehensive record of the interview transcripts.

1. The Use of Scientifically-Acceptable Attributes

A biologist would use the following criterial attributes to distinguish between living and non-living things: movement, respiration, sensitivity, growth, reproduction, excretion, and nutrition. These may be coded in the mnemonic M.R.S. G.R.E.N. An eighth attribute is that of cellular structure. The concept of living is a conjunctive one. That is, an instance is categorised on the joint presence of several of the criterial attributes. Living things will carry out most of these processes. Most plants do not move but they do carry out respiration, growth, reproduction, nutrition, etc. Similarly, some non-living things may carry out several of these processes

but not most of them. A cloud may grow in size but it does not feed, respire, move of its own accord.

All but one of the pupils, from all four class levels, used, during the course of the interview, at least one of the attributes which a biologist might use to distinguish between living and non-living things; their criterial attributes were similar to the scientifically - acceptable ones. Such criterial attributes, are as follows:

a. Movement

"Yes, it can move". (Spider, 007,112,114,125,310,315,510,512,513,514,516)
"No, it can't really move by itself". (Vacuum cleaner, 112,314,317,510, 515)

b. Breathing

"Yes, it lives, it breathes". (Fish, 111,312,313,314,315,316,511,512)
"No, it doesn't breathe". (Bicycle, 312,314,317)

c. Feeding

"Yes, it eats and drinks". (Bird, 116,515)
"No, ... it doesn't drink." (Cloud, 113)

d. Growing

"Yes, because it grows taller". (Tree, 002,112,114,125,311,313,315,316, 510,511,512,513,514,516)

e. The Senses

"Yes, it can see". (Fish, 007,310)
"No, it can't smell and it can't see". (Sun, 007)

f. Reproduction

"Yes, they reproduce". (Fish, 317,511,515)
"Yes, ... and it mates". (Butterfly, 116,317)

g. Cells and Genes

"Yes, ... its got cells". (Fish, grass, butterfly, mushroom, 515)
"... hasn't got cells ... or genes". (Fire, car, 515)

Pupil (515) was the only one to use this attribute.

h. Combination of some of the attributes a-g

"Yes, breathing, eating, flying, movement". (Butterfly, 004,313,515)
"Because he can walk and he can talk and he can breathe and he can do lots of things". (Boy, 004,116,314,315,515)

2. The Categorisation of Non-living Things as Living Things, ie. animism

All but six of the pupils (approximately 80% of the sample) at some stage during the interview, over-extended the scientifically-acceptable concept of living, that is, some things which a biologist would classify as non-living (for example, fire, candle, river, car) were classified by some pupils as living. The pupils may be said to have displayed animistic thought, as documented by Piaget (1929).

This animistic thought resulted from the use of the following criterial attributes:

a. Movement

"Yes, ... it moves in the sky ..." (Cloud, 002,315)

"I sort of think its alive because its always moving, all the time and never dies out". (River, 006,002,312,314,511)

b. Growth

"Cloud, it moves, it starts off little and gets bigger and old. We say it was a living thing". (Cloud, 003,315)

c. Feeding

"Yes, it is feeding because you need to feed it wood to make the fire go... you need to keep on feeding the fire to make it go" (Fire, 006)

d. Requires Oxygen or Breathes

"Yes, it needs oxygen to breathe". (Fire, 312,314,315,511)

e. Reproduction

"Yes, I think so, it creates its own self..." (Cloud, 315)

f. Living and Non-living Characteristics

Some pupils acknowledged that an instance had characteristics of both living and non-living things, and they were consequently unsure of their categorisation.

"In a way but not in another way. It's using up energy, the wood, and it's using up oxygen..it has a fuel of some sort, like we use food as fuel, it uses wood. (But) it doesn't think doesn't have a brain, it hasn't got cells". (Fire, 515)

These pupils were reluctant to make a final decision as to the categorisation and they were not forced to do so, lest the rest of the interview was influenced. Hence it was not resolved if the uncertainty was in a metaphoric or real sense.

g. Sometimes living, sometimes not

Some pupils were unsure of their categorisation if the object was seen to be living at some times and not at others.

The fire and the candle were classified as living when burning, the flame was seen as burning, but the wood and wax were not:

> "Yes, sort of. Its living, (the) lights living but on the other hand, its dead really, because the candle is made by man and it just sits there...it is alive with the light but it isn't walking and all that". (Candle, 001,003,315,511,512)

The vacuum cleaner was considered by some to be living if it was switched on:

> "I'm not sure because its sort of living and it isn't living...its sort of living when its switched on. (But) you have to make it". (Vacuum cleaner, 114,315,316)

The car and the bike were classified by some pupils as living if they were moving:

> "Not until someone starts it up, starts it moving'. (Car,313)

These responses were elicited by questioning to distinguish between dead and non-living. The question 'Has it ever been living?' sometimes evoked the reply that the instance was living at some times but not at others. Hence the candle, fire, car, bike or vacuum cleaner were distinguished from the non-living objects, such as the book, that are never alive.

h. The Use of Non-scientific Attributes

Some pupils used criterial attributes that would not be acceptable to a biologist. These were:

i. A form of energy, such as heat or light

> "Yes, it gives off heat, light and everything". (Sun,310,511,512)
>
> "Yes, its giving off heat..." (Fire,316,513)

ii. Makes a noise

> "Well, when it makes a noise, its sort of living". (Vacuum cleaner, 009,513, 514)

iii. Unusual

> "Yeah, if it was dead, it would be falling out of the universe". (Sun,001)

3. The Use of Idiosyncratic Criterial Attributes

Five pupils (005,124, and 006,008,115) used atypical characteristics as criterial attributes, and exhibited animistic thinking.

a. Usefulness was the sole criterial attribute of pupil (005).

"Yes, it gives you light when its dark and you can cook things on it if your stove isn't going." (Fire)

"Yes, he can...helps his mother. Does things she wants him to do - mowing the lawn, and going up to the shop for her." (Boy)

b. Does or does not rise up from the ground was the only attribute used by pupil (124).

"No...a seagull comes out of..an egg but it doesn't come from underground." (Bird)

The card, illustrating grass, shown towards the end of the interview, gave some insight as to the origin of the use of this attribute.

"Yes, well, the dirt under the grass, well, once you move into a new house, and the grass isn't very clean, you might just dig it up and eventually you water it, roll over it, and its start - all little green things start coming up in the ground - it is living with the dirt under it, pushing it up slowly." (Grass)

c. Survivorship or Durability was a criterial attribute used by pupils 006, 008 and 115.

"And it just keeps on going and going, it doesn't die" (River, 006)

"Yes, it can live (but) some of them get run over on the road and some of them get shot". (Bird,008)

"Yes, a spider can hide up in the corners of a room and that.

(Why does that tell you that its living - that it hides away in cracks?)

Because you can't stand on it and kill it, if its away in cracks." (Spider.115)

4. The Use of Non-criterial Attributes

Many pupils could correctly categorise the instance as an exemplar or non-exemplar of the concept but the characteristic used, while not incorrect, would not be used as a criterial attribute by a biologist. Approximately one half of the pupils, at least once during the interview, responded in this manner.

The following attributes were used:

a. Talking

"Because he can talk." (Boy,004,007,009,113,310)

b. Mind-of-its-own

"Yes, its got its own thinking." (Fish,510; snail,516)

"Yes, because it controls itself, doesn't have to have anyone to control it." (Butterfly,311)

"No, it can't sort of think." (Cloud,510,515)

c. Body Organs

"Yes, its living, its got different parts of the body, got a heart, and a brain." (Butterfly, 003,515)

"No, its metal, it has no brain." (Bike,515)

d. Others

"Yes...it lives in a house." (Snail,113)

"No, because a plane can go right through it." (Cloud,112)

5. The Attributes Used to Categorise the Plant Instances

Five pupils used the following characteristics as criterial attributes with only the plant instances:

a. Colour

"Yes, if its dead, its usually all brown." (Grass,004)

"By their colour." (Grass,310, tree 002,004)

b. Not wilted

"Yes, it stands up." (Tree, 009)

"Yes...if it sort of lopes (flops) around... and it means its dying." (Grass,002)

c. Requirements

"Yes, its living because it needs water, air, and soil to make it go." (Tree,grass,006; mushroom,310)

6. The Distinction Between the Book and the Story

Six pupils differentiated between the story and the book as being living and non-living respectively.

"Yes, it tells about...it has stories in it." (Book,115)

"Yes, what you read in it. If the things that you read are true and living, like reading about trees." (Book,311,312)

"No, oh, it could be living with the story. The story could be living but the book itself isn't." (Book,313,315,512)

7. M.R.S. G.R.E.N.

None of the thirty-two pupils interviewed on his or her concept of living volunteered the nmenonic "M.R.S. G.R.E.N." or made any reference to it as a set of attributes of living things. Six Form 5 pupils were asked at the end of the interview the question "have you heard of M.R.S. G.R.E.N?" All answered "Yes". Their replies to the next question "What does it mean to you?" are exemplified by :

> "Its something about living...there's respiration, sensitivity, growth, reproduction, excretion and I can't remember the "N". (511)
>
> "Well, that's what, those things make people living, people live. (What about a spider?) It uses them". (512)
>
> "To describe living things." (513)
>
> "All the letters stand for words like...helps you, what things can do, how they do it. (What sort of things?) Animals and plants." (514)
>
> "I've heard of it but I haven't learnt it." (516)
>
> "It's the things of life, breathing, respiration, etc...it helps you to distinguish between something that is alive, real..." (515)

All but one of the six pupils could remember what processes most of the letters represented, but only one had the idea that they were a list of criterial attributes of living things. The other five pupils were able to recall but not use the information.

DISCUSSION AND SUMMARY OF RESULTS

Of the thirty-two pupils interviewed as to their concept of living, only five pupils (004,112,125,317,510) had a concept of living similar to that of a biologist. That is, the criterial attributes used and the instances were similar to that of a biologist's.

Most other pupils used at least one of the scientific criterial attributes, for example, movement, breathing, feeding, but they over-extended the scientific concept to include such things as a car, a vacuum cleaner or fire, thus exhibiting animistic thought. Although their rule was similar to that of a biologist, their categorisation of instances and non-instances was not.

As implied, this over-extension usually resulted from the use of only one or two of the eight criterial attributes. For example, pupil (002) considered a cloud living as it moved. He did not consider the other criterial attributes such as nutrition and respiration. A restricted set of criterial attributes had led to an over-extension, in terms of exemplars, of the concept.

One explanation may be that combinatory thinking was impossible for these

pupils if their thinking was characterised by concrete, not formal operations. (Inhelder and Piaget, 1955). If this was so, then it was to be expected that they could consider only one or two characteristics at any one time.

All except one of the Form 5 pupils questioned about M.R.S. G.R.E.N. could recall the processes that the letters represented, but did not recognise their use as criterial attributes of living things. It may be that they, and other pupils, have never been required to categorise instances and non-instances of living things.

Most of the pupils interviewed, despite up to four years of formal biology tuition, had not developed a scientifically-acceptable concept of living. It would appear that their initial concepts had not been significantly shifted by biology teaching. One possible explanation may be that teachers have assumed that pupils had acquired an acceptable concept and have consequently not focussed their teaching on it, nor given the pupils the opportunity to use this conceptual knowledge.

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1. The use of scientifically acceptable attributes to categorise the instances.

   a. Movement
   b. Breathing
   c. Feeding
   d. Growing
   e. The senses
   f. Reproduction
   g. Cells and genes
   h. Combinations of (a - g)

2. The categorisation of non-living things as living things, i.e. Animism using the attributes :

   a. Movement
   b. Growth
   c. Feeding
   d. Breathing
   e. Reproduction
   f. Living and non-living characteristics
   g. Sometimes living, sometimes not
   h. The use of non-scientific attributes

3. The use of idiosyncratic criterial attributes

   a. Usefulness
   b. Does or does not rise up from the ground
   c. Survivorship

4. The use of non-criterial attributes

   a. Talking
   b. Mind-of-its-own
   c. Body organs
   d. Others

5. Attributes used to categorise the plant instances.

6. The distinction between the book and the Story.

7. M.R.S. G.R.E.N.

8. Discussion and summary of Results

Table I The framework of the analysis.

	Standard 4	Form 1	Form 3	Form 5	Total
Number in sample	9	8	8	7	32
Pupil code numbers	(001-009)	(111-116) and (124,125)	(310-317)	(510-516)	

Pupils of above average ability (510,512,515)

Figure 1 : The Interview Sample.

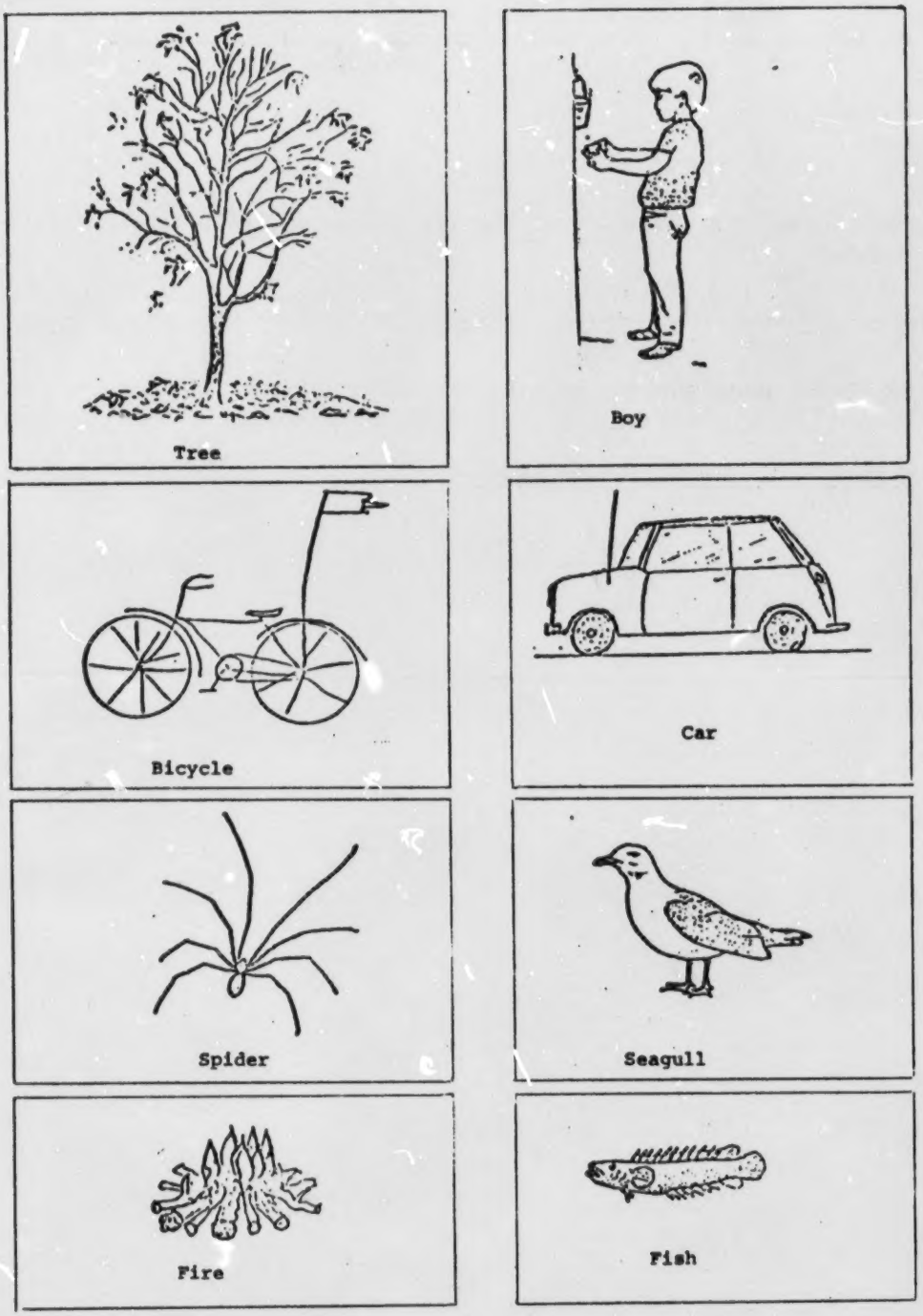

Figure Two: A Sample of the Cards Used in the "Living" Interviews.

APPENDIX A

SUPPLEMENTARY INTERVIEW TRANSCRIPTS

The following are quotations from the interview transcripts that were not included in the analysis sections.

The headings and numbering systems are identical to those used in the analysis section, where an explanation of the headings may also be found.

1. The Use of Scientifically acceptable Attributes

(a) Movement

To classify instances as living:

"He can move." (Boy, 007, 112, 125, 313, 314, 510, 512, 514)

"He can move himself." (Boy, 114, 316)

"Because it can fly." (Bird, 007, 009, 111, 113, 114, 115, 125, 313, 314, 316, 510, 512, 513, 515)

"It can move." (Snail, 007, 009, 111, 112, 115, 114, 116, 125, 310, 311, 313, 314, 315, 316, 317, 510, 512, 513, 515, 516)

"It moves or wriggles." (Worm, 002, 006, 009, 114, 116, 125, 311, 313, 314, 315, 510, 512, 514, 516)

"It can move." (Spider, 007, 112, 114, 125, 310, 315, 510, 512, 513, 514, 516)

"It can move." (Fish, 007, 112, 113, 114, 116, 125, 310, 311, 313, 314, 315, 316, 510, 512, 514)

"Because it can fly and it can walk." (Butterfly, 002, 007, 112, 114, 125, 310, 314, 315, 316, 317, 511, 512, 513, 514, 515, 516)

The attribute was also used to categorise instances as 'non-living':

"No, it doesn't move really, but you have to make it move." (Book, 114)

"No, it moves when someone wants to move it. It doesn't move on its own." (Bike, 004, 007, 112, 113, 125, 510, 511, 512, 516)

"No, because if it moves, it has to have a person to drive it or if it moves down the hill, then the handbrake is taken off. Something has to be done to it, so it can move." (Car, 113, 510, 512, 516)

"No, it can't really move by itself." (Vacuum cleaner, 112, 314, 317, 510, 515)

"No, it may move and the wind has to cause it to move..." (Cloud, 001, 310, 314, 510 512)

"No, it moves along by itself but it has to have the gravity of the ground to make it move." (River, 516)

"No, because that just stays in one place." (Candle, 112)

(b) Breathing

To classify living things:

"He can breathe..." (Boy, 006, 111, 125, 312, 313, 314, 315, 316, 512, 514)

"Because it breathes..." (Bird, 004, 007, 111, 312, 313, 314, 316, 513, 515)

"It can breathe." (Snail, 007, 111, 313, 316, 513, 515)

"Yes, it breathes." (Worm, 111, 314, 513)

"Yes, it breathes." (Mushroom, 314, 316, 511, 512)

"Yes, it lives, it breathes." (Fish, 111, 312, 313, 314, 315, 316, 511, 512)

"It breathes through its leaves." (Grass, 003, 314, 316, 317)

"It can breathe." (Butterfly, 007, 312, 314, 315, 316)

"Yes, a tree's living because it's breathing." (Tree, 316)

"It can breathe." (Spider, 007, 111, 312, 313, 314, 315, 512, 513)

To classify non-living things:

"No, it doesn't breathe." (Bike, 312, 314, 317)

"No, it can't breathe." (Car, 314)

"No, it moves but it's not living... doesn't breathe." (Vacuum cleaner, 111, 314, 317, 516)

"No ... (it) stays still and (it) isn't breathing." (Cloud, 314, 007, 512)

"No ... it hasn't got anything to breathe..." (River, 007, 111, 114, 125, 316, 510)

"No ... it doesn't breathe and that." (Candle, 111)

Some living things were classified as non-living:

"No, it doesn't breathe, I don't think." (Mushroom, 111, 312)
(Tree, 111, 312)

(c) Feeding

To classify living things:

"Because he gets fed and he uses his food up after it's gone to his stomach." (Boy, 006)

"They eat food." (Boy, 008, 113, 315, 515)

"Yes, it drinks and eats." (Bird, 116, 515)

"Yes, it eats." (Snail, 116, 313, 315)

"...and it can eat..." (Fish, 007, 113, 317, 514, 516)

"Yes, it eats." (Grass, 516)

"It eats." (Butterfly, 516)

"Yes, it drinks and eats." (Tree, 113)

"Yes, it moves around and catches its prey and other things." (Spider, 112, 310, 311, 313, 510, 515)

To classify non-living things:

"No, doesn't eat or drink..." (Bike, 116)

"No, because it's just there and ... it doesn't drink ..." (Cloud, 113)

"No ... it doesn't eat or drink." (Fire, candle, 116)

(d) Growing

To classify living things, especially plants:

"Yes, he's alive, he's growing." (Boy, 317)

"Yes, they grow." (Bird, 317, 515)

"Yes, they grow." (Spider, 317, 515)

"Yes, because they grow from when they're like baby fish into a big fish." (Fish, 006, 317, 516)

"Because it grows taller." (Tree, 002, 112, 114, 125, 311, 313, 315, 316, 510, 511, 512, 513, 514, 516)

"Because it gets larger and it gets taller." (Grass, 002, 003, 004, 007, 112, 114, 125, 310, 311, 313, 315, 316, 317, 510, 511, 512, 513, 514, 515, 516)

"It grows." (Mushroom, 003, 004, 006, 007, 112, 114, 125, 311, 313, 315, 316, 317, 510, 511, 512, 513, 514, 515, 516)

"Each spring it puts out new growth, new leaves and it's got branches." (Tree, 310)

(e) The Senses

To classify living things:

"He can hear." (Boy, 007)

"He's got ears and eyes." (Boy, 111)

"... and can feel." (Boy, 310)

"It can see and sense things." (Bird, 007)

"Because it can see and move around." (Snail, 004, 007)

"It can see." (Fish, 007, 310)

"It can feel." (Butterfly, 007)

"It can sense things." (Spider, 007)

To classify non-living things:

"No ... it can't smell and it can't see." (Sun, 007)

"No ... and it hasn't got eyes." (Cloud, 111)

"No, it's like the cloud, it's only water ... it can't (see) - it's blind." (River, 310)

(f) Reproduction

To classify living things:

"Yes, it's a type of insect ... it reproduces." (Worm, 317)

"Yes, grows, reproduces." (Grass, 313, 515; mushroom, 510, 515)

"Yes, it moves and it mates." (Butterfly, 116, 317)

"Yes, they reproduce." (Fish, 317, 511, 515; spider, 515)

(g) Cells, Genes

Only one pupil (515) referred to this attribute, in conjunction with others.

To classify living things:

"Yes ... it's got cells." (Fish, grass, butterfly, mushroom)

To classify non-living things:

"... hasn't got cells ... or genes." (Fire, car)

(h) Combinations of some of the attributes, a - g.

"Because he can walk and he can talk and he can breathe and he's - can do lots of things." (Boy, 004, 116, 314, 315, 515)

"Yes, breathing, eating, flying movement." (Butterfly, 004, 313, 515)

"A snail lives because it eats and it breathes as well, and it walks around and it does its own function. It goes whenever it wants to - wherever the brain tells it to." (Snail, 006)

2. The Categorisation of Non-living Things as Living Things, ie. Animism

(a) Movement

"Not until someone gets on to it, and starts making it move to live." (Bike, 313, 310, 311)

"... and the wax runs down it, and it's moving, so that tells you it's alive." (Candle, 002)

"It moves in the sky, you can see it." (Cloud, 002, 315)

"I sort of think it's alive because it's always moving, all the time and never dies out." (River, 006, 002, 312, 314, 511)

"Yes, (it's living) in one sense - it can move." (Car, 310)

"Yes ... heat, movement." (Sun, 313, 315)

"Yes ... it moves, the gases and that make it sort of alive." (Sun, 516)

(b) Growth

"Cloud, it moves, it starts off little and gets bigger and old. We say it was a living thing." (Cloud, 003, 315)

(c) Feeding

"Yes, it is living because you need to feed it wood to make the fire go ... you need to keep on feeding the fire to make it go." (Fire, 006)

"Yes, it (is because) it has petrol. Just like a human, you have to feed it but a car doesn't rur on food and water, it runs on petrol." (Car, 006)

"Yes, I think it's alive because it needs electricity to make it go ... it's dead when you take electricity away ... it gets nothing to be fed on and so it just dies out." (Vacuum cleaner, 006, 009)

(d) Requires oxygen, or breathes

"Yes, it needs oxygen to breathe." (Fire, 312, 314, 315, 511)

"Yes, when it's lit ... because it takes in oxygen to get it lit and uses it to stay alight." (Candle, 312, 314)

"Yes, it has to have oxygen to keep it alive." (Sun, 314)

(e) Reproduction

"Yes, I think so, it creates its own self, it moves." (Cloud, 315)

(f) Living and Non-living Characteristics

"It's sort of the same as a candle. The flames are alive ... because when the fire goes out, that's dead then ... It is in one circumstance that it does move but it does need air to get it going ... in another sense it isn't alive ... it doesn't have a heart and lungs." (Fire, 003, 512)

"In some ways it's living, the fact that it burns, it is, but it can't feel or move, except when it's spreading ... can't do anything." (Fire, 310)

"In a way but not in another way. It's using up energy, the wood, and it's using up oxygen ... it has a fuel of some sort, like we use food as a fuel, it uses wood. (But) it doesn't think, doesn't have a brain, it hasn't got cells, hasn't got any genes and can't reproduce itself." (Fire, 515)

"Not sure ... it doesn't breathe, (but it has movement)." (River, 513)

(g) Sometimes living; sometimes not

fire, candle

"If you strike a match to it, it is. But if it just goes out, yes, it's dead." (Candle, 002)

"Yeah, it would be living if it was burning - you can see it flickering and it's burning something." (Candle, 114)

"No, it doesn't eat or drink - (Is it living when the flame is burning ?) Kind of - it moves, it eats, takes the air, eats air to stay alive." (Candle, 116)

"Yes and no. It's living when it's burning, and when it runs out of that wax, it will just go out." (Candle, 310)

"Yes, sort of. It's living, (the) light's living but on the other hand, it's dead really because the candle's made by man and it just sits there ... it is alive with the light but it isn't walking and all that ..." (Candle, 001, 003, 315, 511, 512)

"Yes, when it's light it gives off heat and light." (Candle, 514)

vacuum cleaner

"I'm not too sure because it's sort of living and it isn't living ... it's sort of living when it's switched on. (But) you have to make it." (Vacuum cleaner, 114, 315, 316)

"Suppose it is when it's switched on ... it's able to suck up things and ... using power to make it move." (Vacuum cleaner, 310, 514)

"When you put it in the plug it goes. Sort of alive. It's alive mechanically." (Vacuum cleaner, 001)

"No, because it runs on electricity and it has to have something to make it work. (Has it ever been alive?) Yes, when somebody plugs it in and put down the switch and makes it suck up things." (Vacuum cleaner, 007, 113, 116, 311, 313)

car, bike

"No ... because it can't go by itself if no-one was in it. (Is it ever living, is it living at some times?) Yes, when it's been switched on." (Car, 113, 116, 311, 315, 316, 513, 514)

"Not until someone starts it up, starts it moving." (Car, 313)

"No, because it's been made, it sort of hasn't got a brain of its own. (What about when it's moving, the motor's moving in it? Is it living then?) Not sure, it's tricky - you have to make it, put all the parts together, but when it's moving, it's sort of going on its own." (Car, 114, 511)

"No, it has to be moving to be living. (What about when someone's pedalling it down the hill?) Yes. (It's living then?) Yes." (Bike, 311)

"Yes, but it isn't. The pedalling tells you that ... the wheels go round and the bicycle moves." (Bike, 310)

(h) The Use of Non-scientific Attributes

(i) a form of energy such as heat or light

"Yes, because it's giving off heat ..." (Fire, 316, 513) (Candle, 316, 513)

"Yes, when it's light it gives off heat and light." (Candle, 514)

"Yes, gives us light." (Sun, 002, 514)

"Yes, it gives off heat, light and everything." (Sun, 310, 511, 512)

"Yes, it's energy and that." (Sun, 513)

(ii) makes a noise

"Well, when it makes a noise, it's sort of living." (Vacuum cleaner, 009, 513, 514)

(iii) unusual

"All depends if it's man-made or not. If it's man-made, it's not living, but if it's just there it's living. (A man-made river, could you explain that?) Well, say they dig trenches and let the water run through. That's when they're not living because they're not made by itself, it's made by machinery and things like that." (River, 311, 315)

"It's living because clouds are up in the air and they can easily live because they're with God ... they can get drifted away and go in (to) another world because they have to go somewhere." (Cloud, 008)

"Yeah, if it was dead it would be falling out of the universe ... it's shining. If it was dead, it wouldn't be - it would just be black." (Sun, 001)

"Yes, because it's real ... if you didn't have the sun ... you couldn't live or anything else." (Sun, 113)

"Yes, it's always shining, nobody controls it, only the weather and that." (Sun, 311)

3. The Use of Idiosyncratic Criterial Attributes

(a) Usefulness (pupil, 005)

"Yes, he can - for instance, like now when learning, go to school and that ... helps his mother. Does things she wants him to do - mowing the lawn, and going up to the shop for her." (Boy)

"Yes, it gives you light when it's dark and you can cook things on (it) if your stove isn't going." (Fire)

"No, it eats up all the vegetables in your garden." (Snail)

"Yes, it can take us around ... the world, and it can take us to work." (Car)

"Yes, we can eat mushrooms." (Mushroom)

"Yes, it gives us water." (River)

"No ... oh yes, keep all the flies out. It makes a cobweb." (Spider)

(b) Does or does not rise up from the ground (pupil, 124)

"No, a book can be made by man or lady, but it can't grow up from the ground." (Book)

"Yes ... year after year he might be getting taller and taller." (Boy)

"No ... a seagull comes out of an egg but it doesn't come from under the ground." (Bird)

"No ... you have to make a fire, you can't get it to grow ... you can't actually grow it." (Fire)

"Yes, I'd say you could call it living, it's in the ground." (Worm)

"Yes, well, the dirt under the grass, well, once you move into a new house, and the grass isn't very clean, you might just dig it up and eventually you water it, roll over it, and it starts - all little green things start coming up in the ground - it is living with the dirt under it, pushing it up slowly." (Grass)

(c) Survivorship or Durability (pupils 006, 008, 115)

"A candle lives for so long ... when you light it, your wax starts melting and then just keeps on going." (Candle, 006)

"And it just keeps on going and going, it doesn't die." (River, 006)

"It can stay for a long time." (Book, 008)

"Yes, it can live, (but) some of them get run over on the road and some of them get shot." (Bird, 008)

"Yes, it can live, some of the bicycles have a flat tyre, punctures, wheels off and chain broken ... some bikes survive, we have put them in the shed." (Bike, 008)

"Yes, because a vacuum cleaner can live and nothing can - oh, some pieces can get broken off and if some pieces are off - it will not live." (Vacuum cleaner, 008, 115)

"Yes, a spider can hide up in corners of a room and that. (Why does that tell you that it's living - that it hides away in cracks?) Because you can't stand on it and kill it if it's away in cracks." (Spider, 115)

Pupil (008) also used dangerous or not as a criterial attribute. For example:

"Some harmless spiders are living but poisonous ones, like in Australia, that pop out of the holes, well, they're not living because they're dangerous." (Spider, 008)

4. The Use of Non-Criterial Attributes

(a) Talking

"Because he can talk ..." (Boy, 004, 007, 009, 113, 310)

"(It) sings ..." (Bird, 009, 515)

"Yes, ... the way they're carrying on with their noise." (Bird, 512)

(b) Mind-of-its-own

"Yes, because nobody controls him, only himself." (Boy, 311, 515)

"Yes, because he can do things." (Boy, 511)

"Yes, he works to a plan." (Boy, 514)

"Yes, it's got its own thinking." (Fish, 510; snail, 516)

"Yes, an independent thinking thing." (Worm, 515)

"Yes, does actually what it wants to, unless we eat it." (Mushroom, 515)

"Yes, because it controls itself, it doesn't have to have anyone else to control it." (Butterfly, 311)

"No, it can't sort of think." (Cloud, 510, 515)

"No, if you leave it alone, it won't do anything." (Bike, 514)

(c) Body Organs

"Oh, because he's got a heart, and if it stops it means he doesn't live." (Boy, 002, 125, 510)

"Yes ... it has a brain, not as big as ours." (Bird, 116)

"Yes, it has a brain, but it's not as intelligent as us." (Snail, 116, 515)

"Yes, it's got a brain." (Fish, 515; butterfly, spider, 516)

"No, it's metal, it has no brain." (Bike, 515)

"No ... it's a ball of fire, it's not living, I don't think there's any brain or anything." (Sun, 515)

"No, it doesn't move, oh it moves, but it hasn't got a brain ..." (River,116)

"No, it does move ... but it doesn't really function, it doesn't have a heart with organs to keep it going." (Candle, fire, 510)

"Yes, it's living, it's got different parts of the body, got a heart and a brain." (Butterfly, 003, 315)

"No, it moves but it doesn't have anything like organs." (Bike, 510)

(d) Others

"Yes, it can dig holes and that." (Worm, 113)

"Yes, it lives in a house." (Snail, 113)

"You just light it and it goes." (Fire, 002, 004, 112, 113, 114, 125)

"No, because it's been made up." (Bike, 114, 315, 317)

"No ... it's an object, made up of minerals." (Car, 317, 515) (Bike, 004, 515)

"No ... it's just gases ... it's just held there." (Sun, 114)

"No ... it's a source of energy." (Sun, 317)

"No ... because you've got to put electricity into it." (Vacuum cleaner, 004, 124, 125, 512)

"Not really. It's just steam and stuff that's come up from the thing ..." (Cloud, 001, 116, 310, 311, 312, 317, 515, 516)

"No, because a plane can go right through it." (Cloud, 112)

"No, if it was living and we drank the water ... it would be moving around inside us." (River, 112)